

## WHAT IS CLAIMED IS:

1. A wavelength tunable laser comprising:  
a gain means with an active emission section that  
5 generates light;  
a waveguide including a core, the core optically  
coupled to the active emission section for receiving light,  
the core having a refractive index, the core including more  
than one diffraction grating, each diffraction grating  
10 having a different Bragg wavelength;  
a substrate supporting the waveguide and the gain  
means;  
thermo-optical material adjacent to each diffraction  
grating, the refractive index of the thermo-optical material  
15 adjacent to each diffraction grating is less than the  
refractive index of the core; and  
temperature changing means in the thermo-optical  
material adjacent to each diffraction grating.

20 2. The laser of claim 1 wherein, when the temperature  
of the thermo-optical material adjacent each diffraction  
grating, except for a chosen diffraction grating, is less  
than an off temperature, the magnitude of the light  
reflected by each diffraction grating, except for the chosen  
25 diffraction grating, is insufficient to cause single mode  
lasing of the wavelength tunable laser.

3. The laser of claim 2 wherein when the temperature  
of the thermo-optical material adjacent to the chosen  
30 diffraction grating is equal to or greater than the off  
temperature, the magnitude of the light reflected by the

chosen diffraction grating is sufficient to cause single mode lasing of the wavelength tunable laser.

4. The laser of claim 1 wherein, when the temperature  
5 of the thermo-optical material adjacent each diffraction grating, except for a chosen diffraction grating, is greater than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode  
10 lasing of the wavelength tunable laser.

5. The laser of claim 4 wherein when the temperature  
of the thermo-optical material adjacent to the chosen  
diffraction grating is equal to or less than the off  
15 temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single mode lasing of the wavelength tunable laser.

6. The laser of claim 3 wherein the off temperature is  
20 in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

7. The laser of claim 5 wherein the off temperature is  
in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

25 8. The laser of claim 1 wherein the core includes a diffraction grating-free portion, the diffraction grating-free portion including a phase control section.

9. The laser of claim 8 further comprising thermo-  
30 optical material positioned in proximity to the phase control section and temperature changing means in the

thermo-optical material positioned in proximity to the phase control section.

10. The laser of claim 9 wherein the thermo-optical  
5 material is selected from the group comprising a polymer derived from methacrylate, a polymer derived from siloxane, a polymer derived from carbonate, a polymer derived from styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

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11. A wavelength tunable laser comprising:

a gain means with an active emission section that generates light;

a waveguide including a core, the core optically  
15 coupled to the active emission section for receiving light, the core having a refractive index, the core including more than one diffraction grating, each diffraction grating having a Bragg wavelength;

a substrate supporting the waveguide and the gain  
20 means, the substrate including an index loading region adjacent to each diffraction grating;

thermo-optical material adjacent to each diffraction grating, the refractive index of the thermo-optical material adjacent to each diffraction grating is less than the  
25 refractive index of the core; and

temperature changing means in the thermo-optical material adjacent to each diffraction grating wherein the product of a pitch associated with each diffraction grating and an effective refractive index of an optical mode as the  
30 optical mode propagates by each diffraction grating is different for each diffraction grating.

12. The laser of claim 11 wherein, when the temperature of the thermo-optical material adjacent to each diffraction gratings, except for a chosen diffraction  
5 grating, is less than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

10 13. The laser of claim 12 wherein, when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or greater than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single  
15 mode lasing of the wavelength tunable laser.

14. The laser of claim 11 wherein, when the temperature of the thermo-optical material adjacent to each diffraction gratings, except for a chosen diffraction  
20 grating, is greater than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

25 15. The laser of claim 14 wherein when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or less than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single  
30 mode lasing of the wavelength tunable laser.

16. The laser of claim 12 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

17. The laser of claim 14 wherein the off temperature  
5 is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

18. The laser of claim 11 wherein the core includes a diffraction grating-free portion, the diffraction grating-free portion including a phase control section.  
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19. The laser of claim 18 further comprising thermo-optical material positioned in proximity to the phase control section and temperature changing means in the thermo-optical material positioned in proximity to the phase  
15 control section.

20. The laser of claim 19 wherein the thermo-optical material is selected from the group comprising a polymer derived from methacrylate, a polymer derived from siloxane, a polymer derived from carbonate, a polymer derived from styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.  
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21. A wavelength tunable laser comprising:  
25 a gain means with an active emission section that generates light;

a waveguide including a core and material within the waveguide, the core optically coupled to the active emission section for receiving light, the core having a refractive  
30 index;

regions of gratings in the waveguide, the regions of gratings including thermo-optical material, the refractive index of the thermo-optical material is less than the refractive index of the core;

5 a substrate supporting the waveguide and the gain means; and

temperature changing means in the thermo-optical material.

10 22. The laser of claim 21 wherein, when the temperature of the thermo-optical material adjacent each diffraction grating, except for a chosen diffraction grating, is less than an off temperature, the magnitude of the light reflected by each diffraction grating, except for  
15 the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

23. The laser of claim 22 wherein when the temperature of the thermo-optical material adjacent to the chosen  
20 diffraction grating is equal to or greater than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single mode lasing of the wavelength tunable laser.

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24. The laser of claim 21 wherein, when the temperature of the thermo-optical material adjacent each diffraction grating, except for a chosen diffraction grating, is greater than an off temperature, the magnitude  
30 of the light reflected by each diffraction grating, except

for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

25. The laser of claim 24 wherein when the temperature  
5 of the thermo-optical material adjacent to the chosen  
diffraction grating is equal to or less than the off  
temperature, the magnitude of the light reflected by the  
chosen diffraction grating is sufficient to cause single  
mode lasing of the wavelength tunable laser.

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26. The laser of claim 23 wherein the off temperature  
is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

27. The laser of claim 25 wherein the off temperature  
15 is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

28. The laser of claim 21 wherein the core includes a  
diffraction grating-free portion, the diffraction grating-  
free portion including a phase control section.

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29. The laser of claim 28 further comprising thermo-  
optical material positioned in proximity to the phase  
control section and temperature changing means in the  
thermo-optical material positioned in proximity to the phase  
25 control section.

30. The laser of claim 29 wherein the thermo-optical  
material is selected from the group comprising a polymer  
derived from methacrylate, a polymer derived from siloxane,  
30 a polymer derived from carbonate, a polymer derived from

styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

31. A wavelength tunable laser comprising:

5 a gain means with an active emission section that generates light;

a waveguide including a core and material within the waveguide, the core optically coupled to the active emission section for receiving light, the core having a refractive  
10 index;

regions of gratings in the waveguide, the regions of gratings including thermo-optical material, the refractive index of the thermo-optical material is less than the refractive index of the core;

15 a substrate supporting the waveguide and the gain means, the substrate including an index loading region adjacent to each diffraction grating; and

temperature changing means in the thermo-optical material wherein the product of a pitch associated with each  
20 diffraction grating and an effective refractive index of an optical mode as the optical mode propagates by each diffraction grating is different for each diffraction grating.

25 32. The laser of claim 31 wherein, when the temperature of the thermo-optical material adjacent to each diffraction gratings, except for a chosen diffraction grating, is less than an off temperature, the magnitude of the light reflected by each diffraction grating, except for  
30 the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.



33. The laser of claim 32 wherein, when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or greater than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single mode lasing of the wavelength tunable laser.

34. The laser of claim 31 wherein, when the temperature of the thermo-optical material adjacent to each diffraction gratings, except for a chosen diffraction grating, is greater than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

35. The laser of claim 34 wherein when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or less than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single mode lasing of the wavelength tunable laser.

36. The laser of claim 32 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

37. The laser of claim 34 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

38. The laser of claim 31 wherein the core includes a diffraction grating-free portion, the diffraction grating-free portion including a phase control section.

5 39. The laser of claim 38 further comprising thermo-optical material positioned in proximity to the phase control section and temperature changing means in the thermo-optical material positioned in proximity to the phase control section.

10 40. The laser of claim 39 wherein the thermo-optical material is selected from the group comprising a polymer derived from methacrylate, a polymer derived from siloxane, a polymer derived from carbonate, a polymer derived from  
15 styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

41. A wavelength tunable filter comprising:  
a waveguide including a core, the core having a  
20 refractive index, the core including more than one diffraction grating, each diffraction grating having a different Bragg wavelength;  
a substrate supporting the waveguide;  
thermo-optical material adjacent to each diffraction  
25 grating, the refractive index of the thermo-optical material adjacent to each diffraction grating is less than the refractive index of the core; and  
temperature changing means in the thermo-optical material adjacent to each diffraction grating.

42. The filter of claim 41 wherein, when the temperature of the thermo-optical material adjacent each diffraction grating, except for a chosen diffraction grating, is less than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

43. The filter of claim 42 wherein when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or greater than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single mode lasing of the wavelength tunable laser.

44. The filter of claim 41 wherein, when the temperature of the thermo-optical material adjacent each diffraction grating, except for a chosen diffraction grating, is greater than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

45. The filter of claim 44 wherein when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or less than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single mode lasing of the wavelength tunable laser.

46. The filter of claim 43 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

47. The filter of claim 45 wherein the off temperature  
5 is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

48. The filter of claim 41 wherein the core includes a diffraction grating-free portion, the diffraction grating-free portion including a phase control section.  
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49. The filter of claim 48 further comprising thermo-optical material positioned in proximity to the phase control section and temperature changing means in the thermo-optical material positioned in proximity to the phase  
15 control section.

50. The filter of claim 49 wherein the thermo-optical material is selected from the group comprising a polymer derived from methacrylate, a polymer derived from siloxane, a polymer derived from carbonate, a polymer derived from styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.  
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51. A wavelength tunable filter comprising:  
25 a waveguide including a core, the core having a refractive index, the core including more than one diffraction grating, each diffraction grating having a Bragg wavelength;

a substrate supporting the waveguide, the substrate  
30 including an index loading region adjacent to each diffraction grating;

thermo-optical material adjacent to each diffraction grating, the refractive index of the thermo-optical material adjacent to each diffraction grating is less than the refractive index of the core; and

5 temperature changing means in the thermo-optical material adjacent to each diffraction grating wherein the product of a pitch associated with each diffraction grating and an effective refractive index of an optical mode as the optical mode propagates by each diffraction grating is  
10 different for each diffraction grating.

52. The filter of claim 51 wherein, when the temperature of the thermo-optical material adjacent to each diffraction gratings, except for a chosen diffraction  
15 grating, is less than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

20 53. The filter of claim 52 wherein, when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or greater than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single  
25 mode lasing of the wavelength tunable laser.

54. The filter of claim 51 wherein, when the temperature of the thermo-optical material adjacent to each diffraction gratings, except for a chosen diffraction  
30 grating, is greater than an off temperature, the magnitude of the light reflected by each diffraction grating, except

for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

55. The filter of claim 54 wherein when the  
5 temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or less than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single mode lasing of the wavelength tunable laser.

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56. The filter of claim 52 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

57. The filter of claim 54 wherein the off temperature  
15 is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

58. The filter of claim 51 wherein the core includes a diffraction grating-free portion, the diffraction grating-free portion including a phase control section.

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59. The filter of claim 58 further comprising thermo-optical material positioned in proximity to the phase control section and temperature changing means in the thermo-optical material positioned in proximity to the phase  
25 control section.

60. The filter of claim 59 wherein the thermo-optical material is selected from the group comprising a polymer derived from methacrylate, a polymer derived from siloxane,  
30 a polymer derived from carbonate, a polymer derived from

styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

. 61. A wavelength tunable filter comprising:

5 a waveguide including a core and material within the waveguide, the core optically coupled to the active emission section for receiving light, the core having a refractive index;

regions of gratings in the waveguide, the regions of  
10 gratings including thermo-optical material, the refractive index of the thermo-optical material is less than the refractive index of the core;

a substrate supporting the waveguide; and  
temperature changing means in the thermo-optical  
15 material.

62. The filter of claim 61 wherein, when the temperature of the thermo-optical material adjacent each diffraction grating, except for a chosen diffraction  
20 grating, is less than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

25 63. The filter of claim 62 wherein when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or greater than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single  
30 mode lasing of the wavelength tunable laser.

64. The filter of claim 61 wherein, when the temperature of the thermo-optical material adjacent each diffraction grating, except for a chosen diffraction  
5 grating, is greater than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

10 65. The filter of claim 64 wherein when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or less than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single  
15 mode lasing of the wavelength tunable laser.

66. The filter of claim 63 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

20 67. The filter of claim 65 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

68. The filter of claim 61 wherein the core includes a diffraction grating-free portion, the diffraction grating-  
25 free portion including a phase control section.

69. The filter of claim 68 further comprising thermo-optical material positioned in proximity to the phase control section and temperature changing means in the  
30 thermo-optical material positioned in proximity to the phase control section.



70. The filter of claim 69 wherein the thermo-optical material is selected from the group comprising a polymer derived from methacrylate, a polymer derived from siloxane, a polymer derived from carbonate, a polymer derived from styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

71. A wavelength tunable filter comprising:  
a waveguide including a core and material within the waveguide, the core optically coupled to the active emission section for receiving light, the core having a refractive index;

regions of gratings in the waveguide, the regions of gratings including thermo-optical material, the refractive index of the thermo-optical material is less than the refractive index of the core;

a substrate supporting the waveguide, the substrate including an index loading region adjacent to each diffraction grating; and

temperature changing means in the thermo-optical material wherein the product of a pitch associated with each diffraction grating and an effective refractive index of an optical mode as the optical mode propagates by each diffraction grating is different for each diffraction grating.

72. The filter of claim 71 wherein, when the temperature of the thermo-optical material adjacent to each diffraction gratings, except for a chosen diffraction grating, is less than an off temperature, the magnitude of

the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

5           73. The filter of claim 72 wherein, when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or greater than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single  
10 mode lasing of the wavelength tunable laser.

74. The filter of claim 71 wherein, when the temperature of the thermo-optical material adjacent to each diffraction gratings, except for a chosen diffraction  
15 grating, is greater than an off temperature, the magnitude of the light reflected by each diffraction grating, except for the chosen diffraction grating, is insufficient to cause single mode lasing of the wavelength tunable laser.

20           75. The filter of claim 74 wherein when the temperature of the thermo-optical material adjacent to the chosen diffraction grating is equal to or less than the off temperature, the magnitude of the light reflected by the chosen diffraction grating is sufficient to cause single  
25 mode lasing of the wavelength tunable laser.

76. The filter of claim 72 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

30           77. The filter of claim 74 wherein the off temperature is in the range of  $-65^{\circ}$  to  $100^{\circ}$  Celsius.

78. The filter of claim 71 wherein the core includes a diffraction grating-free portion, the diffraction grating-free portion including a phase control section.

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79. The filter of claim 78 further comprising thermo-optical material positioned in proximity to the phase control section and temperature changing means in the thermo-optical material positioned in proximity to the phase control section.

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80. The filter of claim 79 wherein the thermo-optical material is selected from the group comprising a polymer derived from methacrylate, a polymer derived from siloxane, a polymer derived from carbonate, a polymer derived from styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

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